

OVERVIEW

Aircraft Vulnerability: A Survey of Combat and Peacetime Experience

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OVERVIEW

DEFINITIONS

SURVIVABILITY:	THE CAPABILITY OF AN AIRCRAFT TO AVOID OR WITHSTAND A MAN-MADE HOSTILE ENVIRONMENT WITHOUT SUSTAINING AN IMPAIRMENT OF ITS ABILITY TO ACCOMPLISH ITS DESIGNATED MISSION
SUSCEPTIBILITY:	THE DEGREE TO WHICH A DEVICE, EQUIPMENT, OR WEAPONS SYSTEM IS OPEN TO EFFECTIVE ATTACK DUE TO ONE OR MORE INHERENT WEAKNESSES
VULNERABILITY:	THE CHARACTERISTICS OF A SYSTEM WHICH CAUSES IT TO SUFFER A DEFINITE DEGRADATION (INCAPABILITY TO PERFORM THE DESIGNATED MISSION) AS A RESULT OF HAVING BEEN SUBJECTED TO A CERTAIN LEVEL OF EFFECTS IN AN UNNATURAL (MAN-MADE) HOSTILE ENVIRONMENT

REF: MIL-STD-2089

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EQUATIONS

$$P_S = 1 - P_K$$

$$P_S = 1 - (P_H) (P_{K/H})$$

SURVIVABILITY = 1 - (SUSCEPTIBILITY) (VULNERABILITY)

- TACTICS
- SIGNATURE REDUCTIONS
- COUNTERMEASURES
- VEHICLE PERFORMANCE
- DEFENSE SUPPRESSION
- THREAT DEFINITION

- DAMAGE TOLERANCE
- DAMAGE RESISTANCE

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HISTORICAL ATTRITION

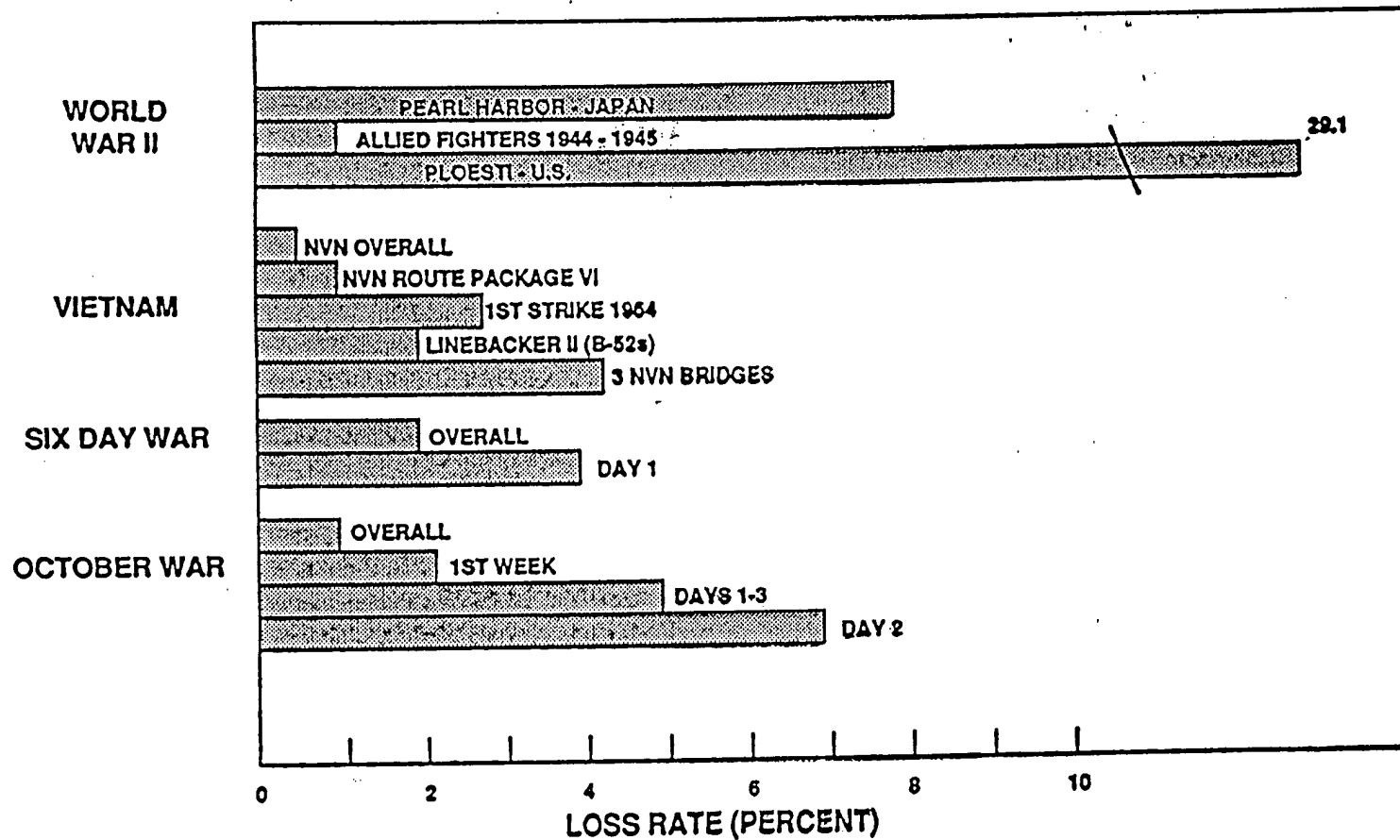
MINIMUM ACCEPTABLE SURVIVABILITY, OFTEN KEYED TO DURATION OF ENGAGEMENT

- **INDIVIDUAL RAIDS MAY EXPERIENCE HIGH LOSS RATES - ACCEPTABLE IF MISSION CRITICAL**
- **SHORT CONFLICT - ATTRITION MANAGED TO PRESERVE FORCE UNTIL RESUPPLY**
- **LONG CONFLICT - ACCEPTABLE ATTRITION IS A FUNCTION OF NATIONAL ECONOMY AND THE WILL TO FIGHT**

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HISTORICAL MANNED AIRCRAFT ATTRITION RATES



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HISTORICAL LOSS DATA

WORLD WAR II

KOREA

SOUTHEAST ASIA

FALKLANDS

GRENADA

LIBYA

DESERT STORM

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UNCLASSIFIED SIMPLE CALCULATIONS - THEORY (U)

$$P_s = 1 - [P_H * P_{K/H}]$$

SURVIVABILITY

SUSCEPTIBILITY
NUMBER OF A/C HIT
NUMBER OF EXPOSURES
COMPUTE RATIO

VULNERABILITY
NUMBER OF A/C KILLED
NUMBER OF A/C HIT
COMPUTE RATIO

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OVERVIEW

THE REALITY OF IT ALL (U)

- GETTING THE DATA - WARFIGHTERS VS HISTORIANS
 - SEA SPECIALTY TEAMS
 - DESERT STORM EXPERIENCE
- MANY COLLECTORS - MANY STANDARDS
 - DATA ARE ALWAYS MISSING
 - APPLES MAY BE MIXED WITH ORANGES
 - ASSUMPTIONS OR JUDGMENTS ARE MADE
 - CAVEATS AND QUALIFIERS ARE FORGOTTEN
- UNCERTAINTY ABOUNDS!

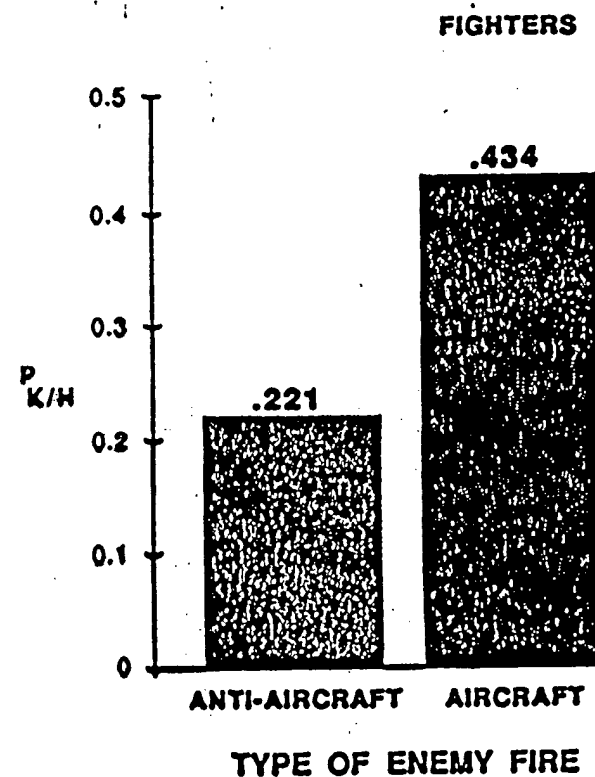
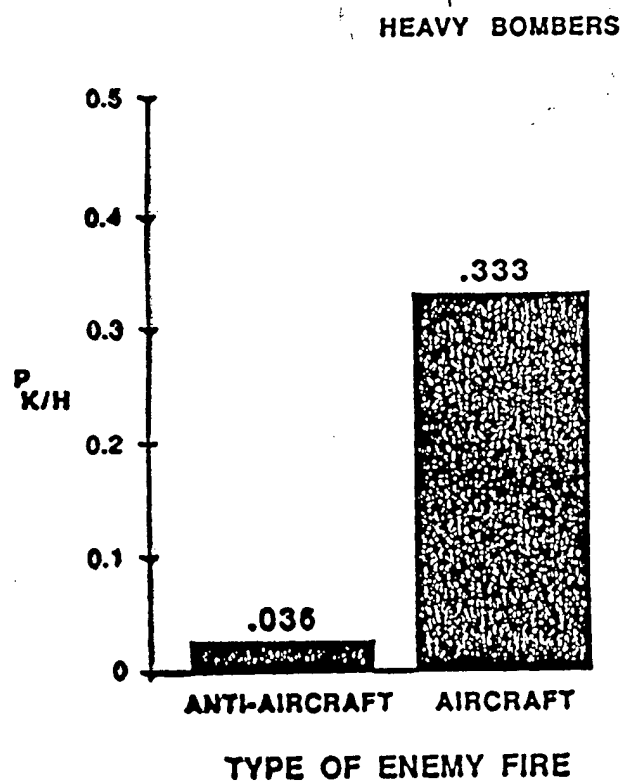
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WORLD WAR II

OVERVIEW

WORLD WAR II AIRCRAFT VULNERABILITY (PK/H) DATA (U)

DATA FROM ALL THEATERS



*B-17, B-24, PB4Y

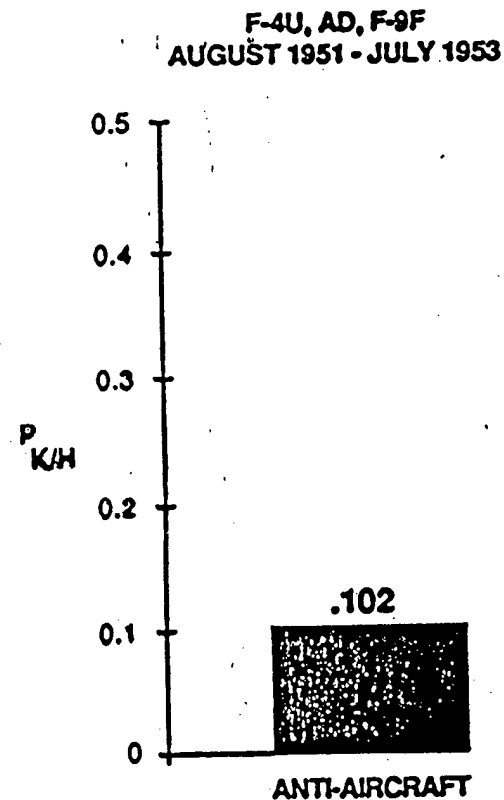
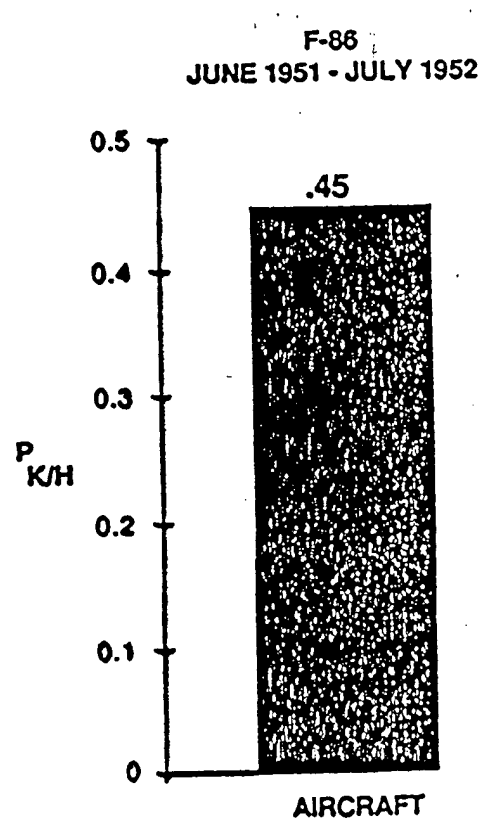
NOTE - $P_{K/H}$ EQUALS # AIRCRAFT LOST / # AIRCRAFT HIT

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KOREAN WAR

OVERVIEW

KOREAN WAR AIRCRAFT VULNERABILITY (PK/H) DATA (U)



TYPE OF THREAT

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SOUTHEAST ASIA

OVERVIEW

AIRCRAFT LOST

	HOSTILE ACTION IN AIR	ALL HOSTILE ACTION	TOTAL (WITH OPERATIONAL)
FIXED WING	2420	2561	3720
HELICOPTER	2382	2587	4869
TOTAL	4801	5148	8589

OVER 30,000 RECORDED COMBAT DAMAGE INCIDENTS

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OVERVIEW**BY COUNTRY**

	FIXED WING	HELICOPTER
CAMBODIA	36	123
LAOS	478	70
NORTH VIETNAM	1096	12
SOUTH VIETNAM	944	2381
THAILAND	3	1
OTHER	<u>4</u>	<u>0</u>
	2561	2587

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OVERVIEW**BY SERVICE****US MILITARY AIRCRAFT LOSSES IN SOUTHEAST ASIA
(HOSTILE ACTION ONLY)**

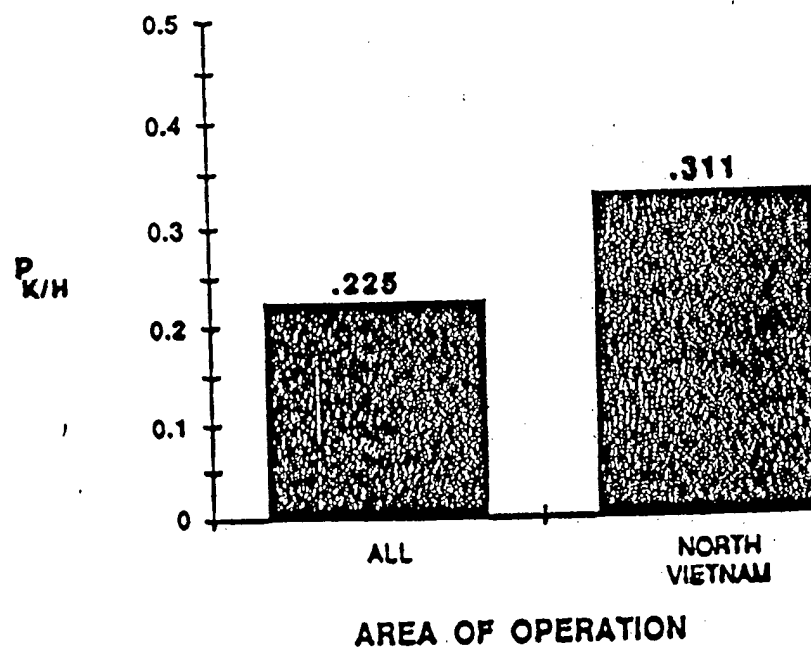
SERVICE	FIXED WING	ROTARY WING	TOTAL
USAF	1679	58	1737
USN	531	13	544
USMC	194	270	464
USA	157	2246	2403
TOTAL	2561	2587	5148

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SOUTHEAST ASIA VULNERABILITY (PK/H) DATA (U)

ALL U.S. FIXED-WING AIRCRAFT, ATTACK SORTIES
CY 1996 - CY 1973



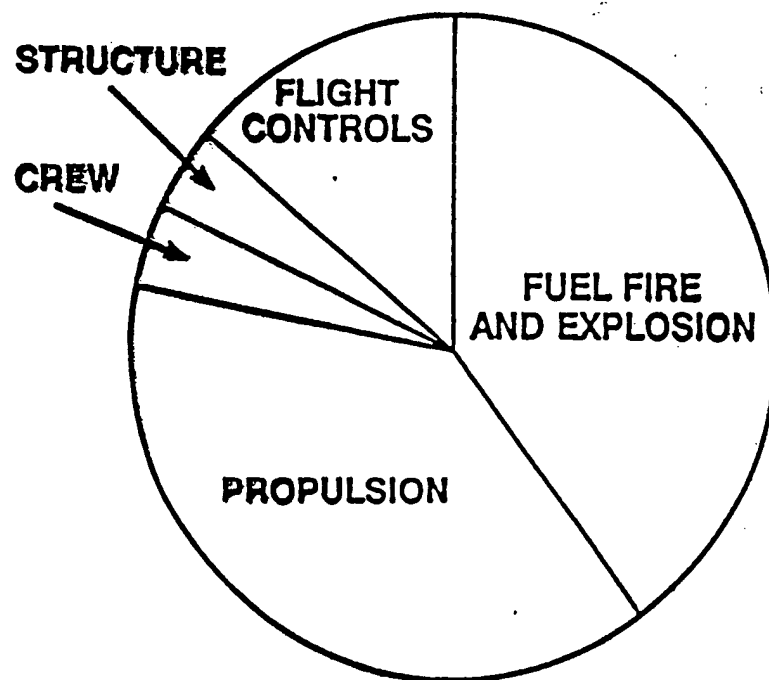
NOTE - NUMBER MAY BE HIGH; NUMBER OF DOCUMENTED DAMAGE INCIDENTS MAY BE LOW

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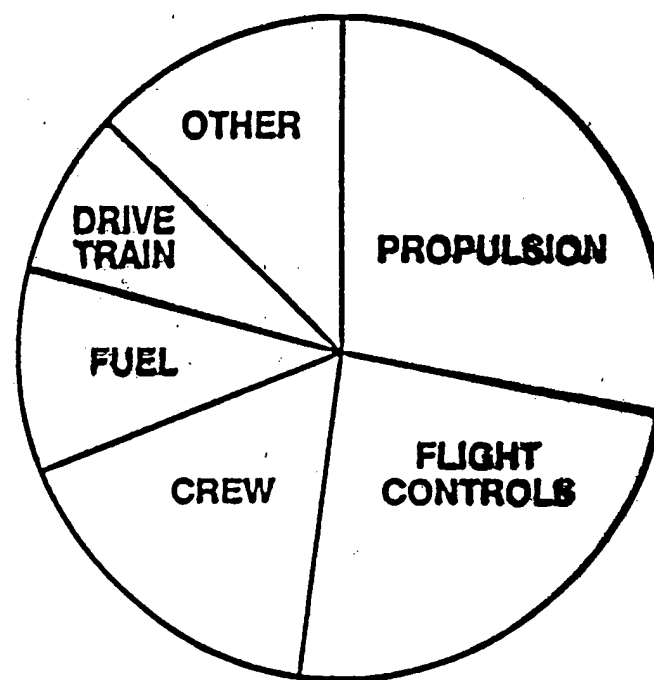
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CONTRIBUTORS TO VULNERABILITY SOUTHEAST ASIA DATA

FIXED-WING



ROTARY-WING



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FALKLANDS
1982

OVERVIEW

FALKLANDS - BRITISH HARRIER LOSSES (U)

TYPE AIRCRAFT

SEA HARRIER

RAF HARRIER

RAF HARRIER

RAF HARRIER

SEA HARRIER

THREAT

AAA

BLOWPIPE

AAA

AAA

ROLAND

TOTAL - 5

NOTE - DATA SYNTHESIZED FROM OPEN SOURCES

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OVERVIEW

FALKLANDS - BRITISH HELICOPTER LOSSES (U)

TYPE AIRCRAFT

NUMBER LOST

SEA KING

2

COMMANDOS

3

WESSEX

10-12

SCOUT

1

GAZELLE

SEVERAL

LYNX

SEVERAL

NOTE - DATA SYNTHESIZED FROM OPEN SOURCES

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FALKLANDS - ARGENTINA AIRCRAFT LOSSES (U)

<u>TYPE AIRCRAFT</u>	<u>NUMBER LOST</u>
SKYHAWK	31
MIRAGE	26
PUCARA	23
HELICOPTERS	18
OTHER	11
<hr/>	
TOTAL:	109

NOTE - BRITISH CLAIMS SYNTHESIZED FROM OPEN SOURCES

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GRENADA
OCTOBER 1983

OVERVIEW

GRENADA SCOREBOARD (U)

THREAT - 7.62 MM, 12.7 MM, 14.5 MM, 23 MM

<u>TYPE AIRCRAFT</u>	<u>NUMBER LOST</u>	<u>NUMBER DAMAGED</u>
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AH-1T	2	?
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CH-46E	1	?
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UH-69A	4 (?)	5
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TOTAL:	7	11
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Pk/h = .38

NOTE - DATA ARE FROM OPEN SOURCES

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LIBYA
APRIL 1986

OVERVIEW

LIBYA SCOREBOARD (U)

TYPE AIRCRAFT	NUMBER ENGAGED	NUMBER LOST
F-111F	13	1
A-6E	14	0
F/A-18	6	0
A-7E	6	0
TOTAL:	39	1

**NOTE - APPROXIMATELY 25 AIRCRAFT ATTACKED THE TARGETS
DATA SYNTHESIZED FROM OPEN SOURCES**

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DESERT STORM

1991

OVERVIEW

ANALYSIS

TOTAL SORTIES -- 93228*

HIT RATE / 1000 = .68

LOSS RATE / 1000 = .3

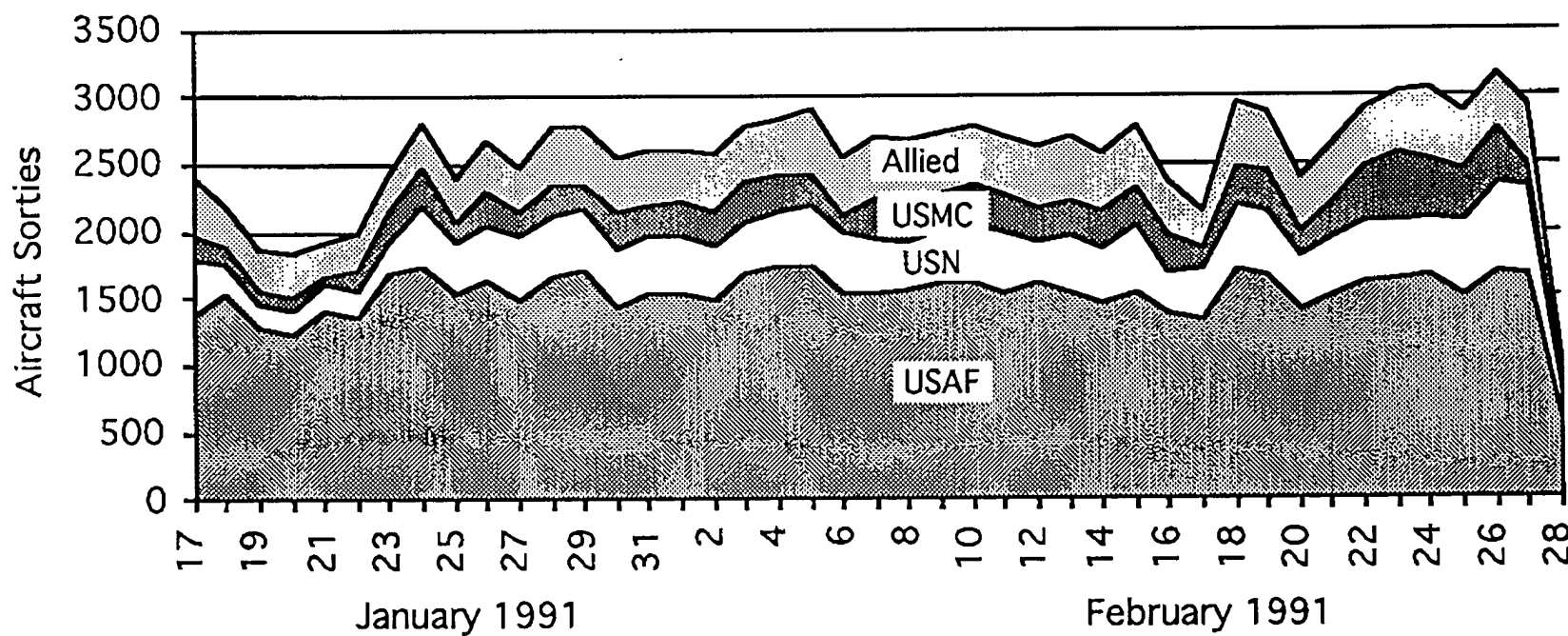
PROBABILITY OF KILL/HIT = .41

*** EXCLUDING ARMY SORTIES, HITS, AND LOSSES**

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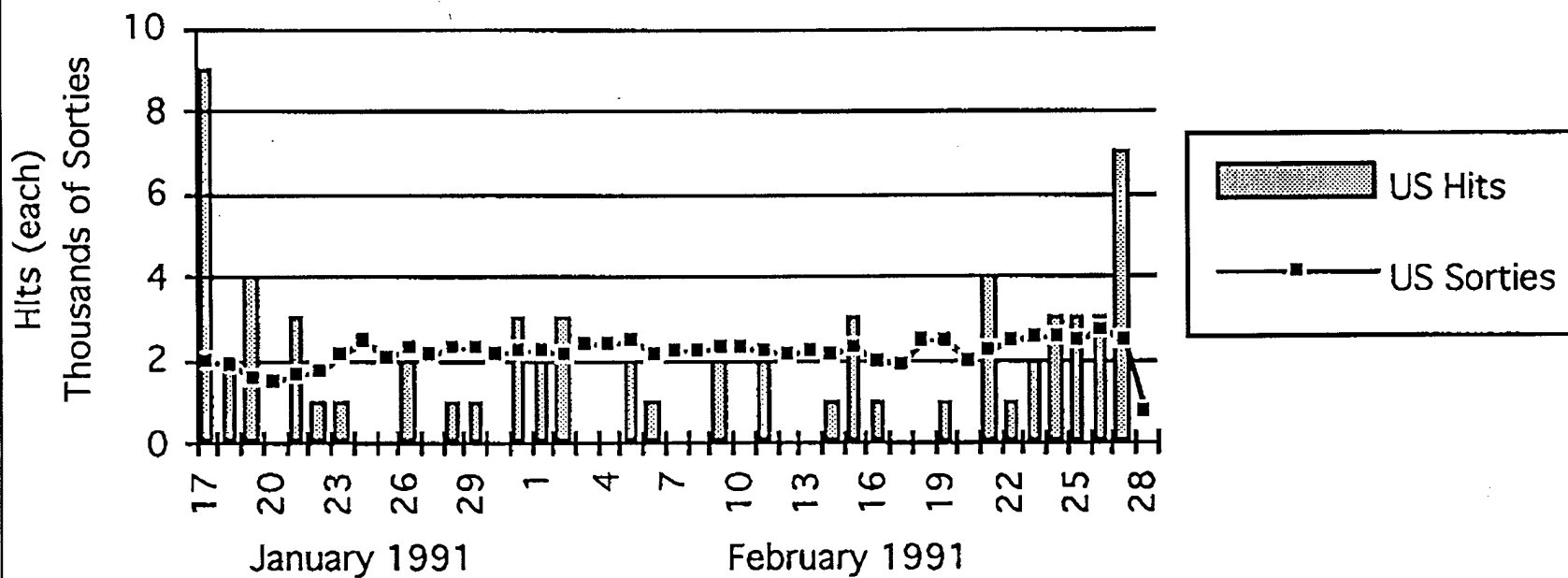
MISSION/CAMPAIGN

DESERT STORM SORTIES

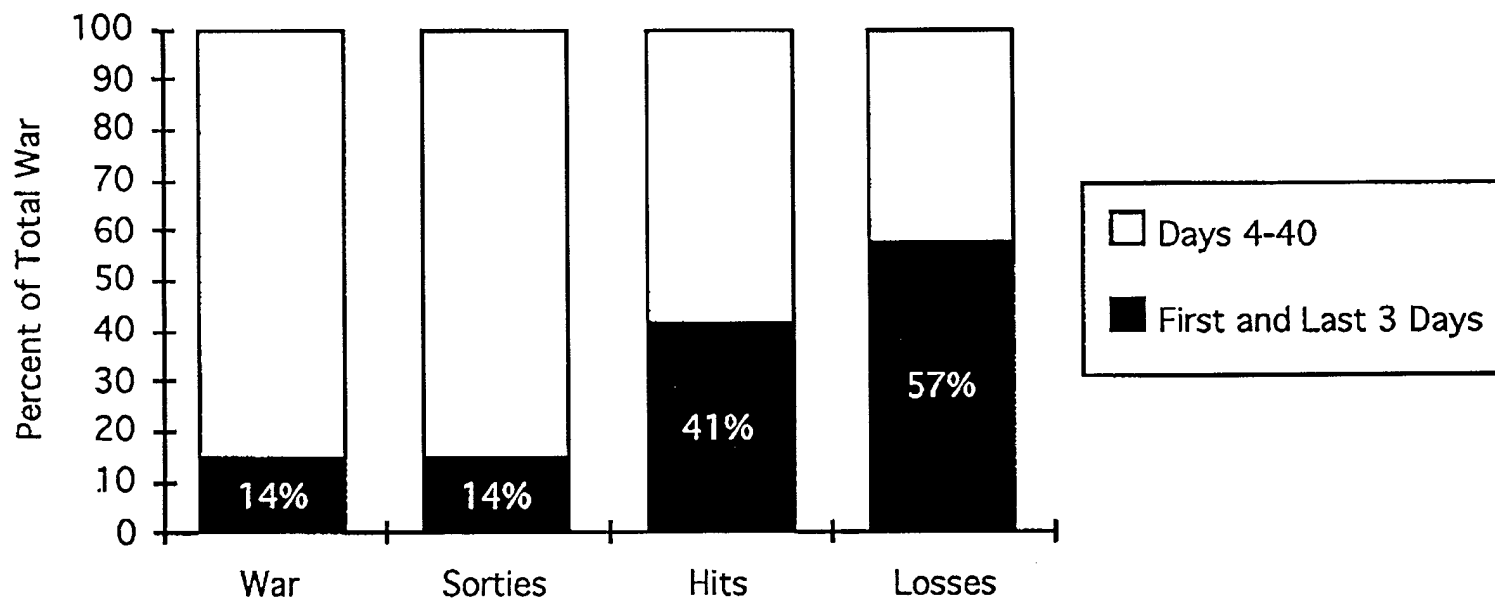


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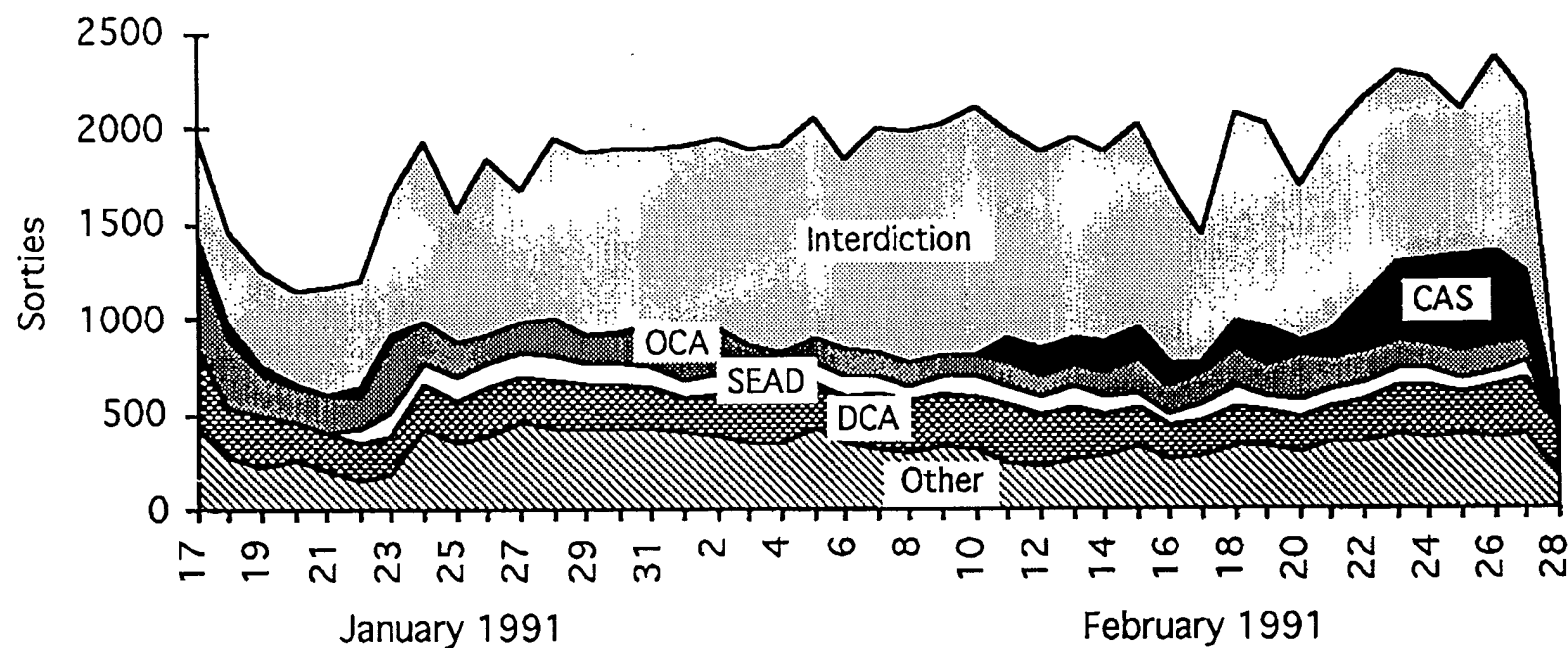
DESERT STORM DAILY SORTIES & HITS



DESERT STORM START/END DAYS



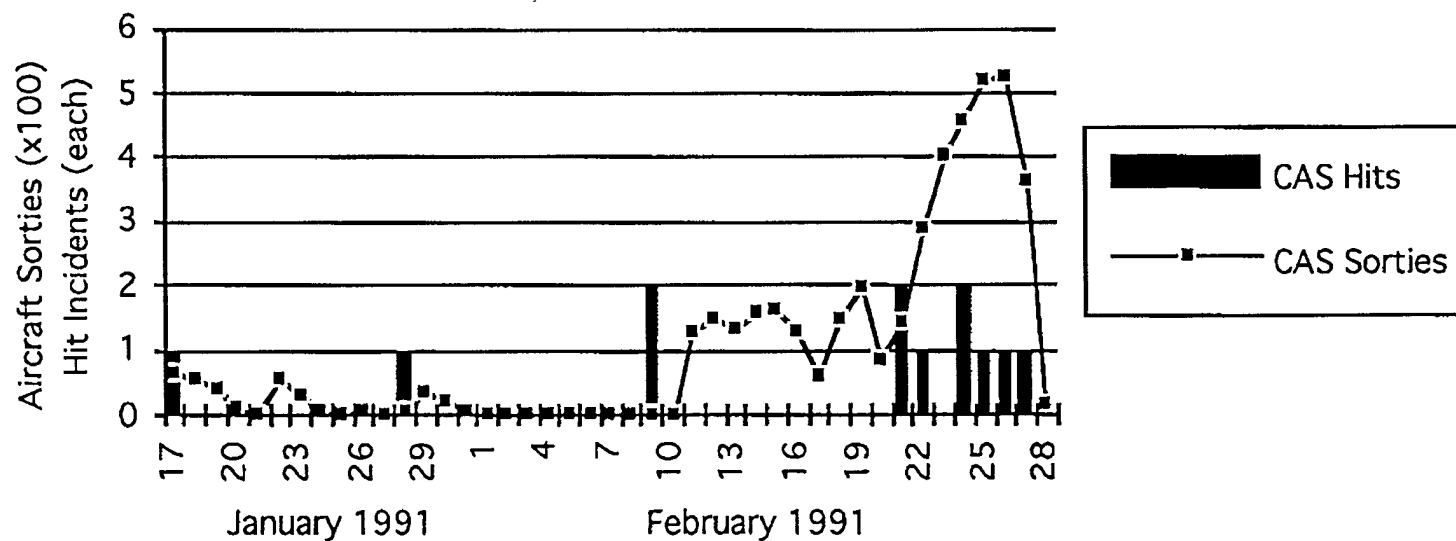
DESERT STORM SORTIES BY MISSION



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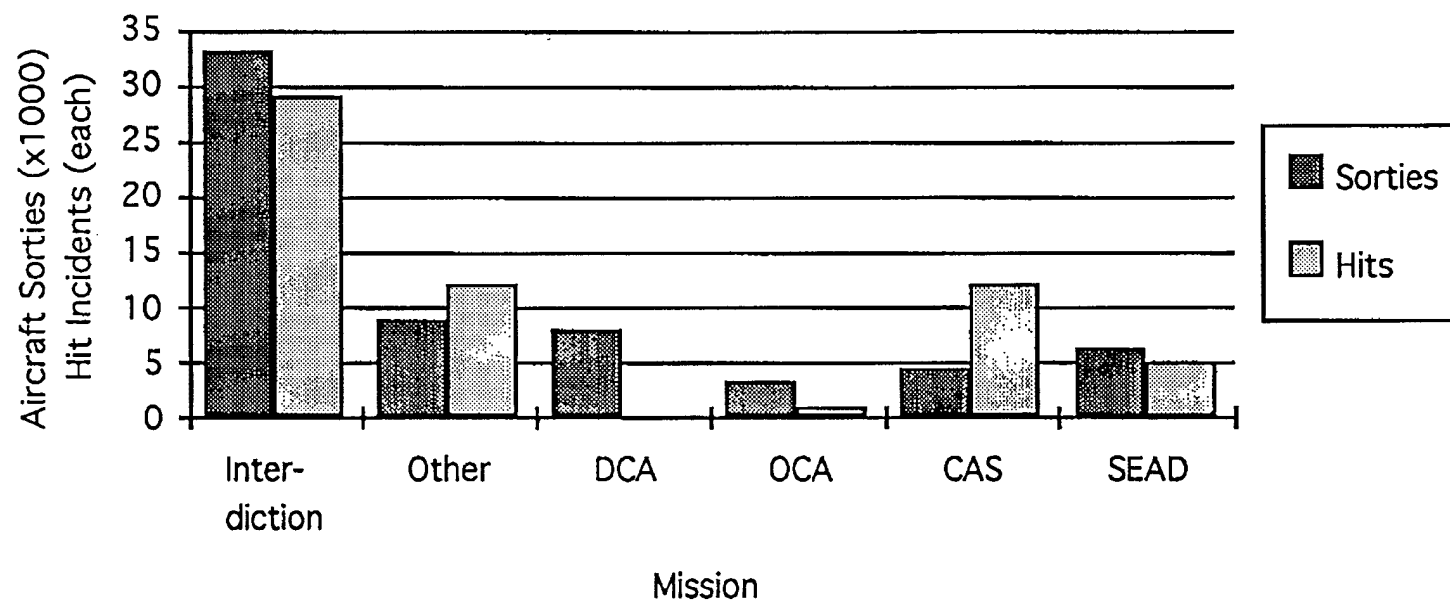
MISSION/CAMPAIGN

DESERT STORM CAS

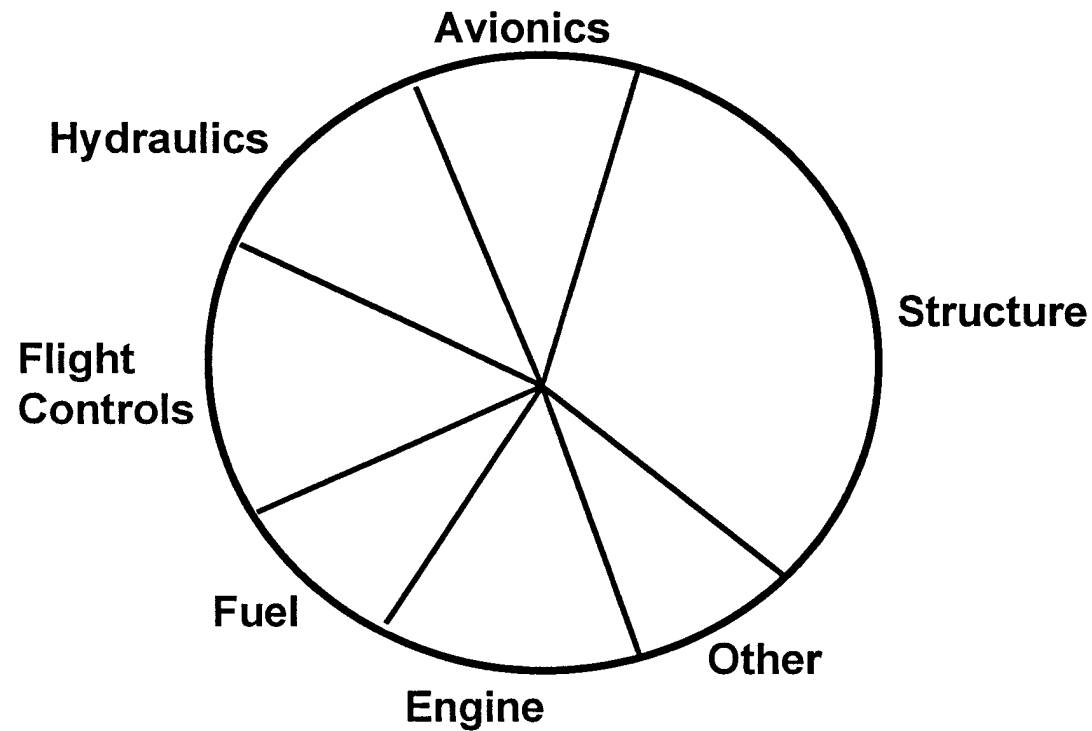


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DESERT STORM HITS BY MISSION



SUBSYSTEM DAMAGE



NOTE: DOES NOT INCLUDE 20 AIRCRAFT WITH UNKNOWN SUBSYSTEM DAMAGE

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OBSERVATION

**PROBABILITY OF KILL GIVEN A HIT HAS BEEN RELATIVELY
CONSTANT FOR LAST 60 YEARS**

**THE QUESTION - DOES THIS MEAN THAT THE VULNERABILITY
REDUCTION COMMUNITY HAS FAILED?**

THE ANSWER - NO, THE THREAT HAS EVOLVED

- SEA PRIMARILY SA/AAA
- DESERT STORM MORE PF SAMS & IR SAMS

**THE CHALLENGE - TO CONTINUE TO KEEP PACE WITH
INCREASING LETHALITY OF THE THREAT.**

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SUMMARY

LOSSES AND DAMAGE MUCH LESS THAN EXPECTED

- SUSCEPTIBILITY LOWER
- THREAT CAPABILITY/TRAINING LOWER
- TACTICS - SURPRISE, SEAD, TARGET SELECTION

MISCELLANEOUS OBSERVATIONS

- SOME MISSIONS INHERENTLY MORE DANGEROUS
- SOME DATA QUIRKS INTERDICTION VS SEAD
- PROBABILITY OF KILL GIVEN HIT AS EXPECTED
- AIR POWER CRUCIAL TO DECISIVE, SUCCESSFUL, LOW LOSS CAMPAIGN

COMBAT DATA USES IN ANALYSIS

- **To Provide Guidance on Encounter Conditions/Threats**
- **To Substantiate Flight Critical Subsystems & Responses**
- **To Provide Data to Support Analysis Inputs/Compare to Outputs**
- **To Substantiate Single Hit Analysis Vs. Multiple Hit Analysis**
- **To Support Definition of Possible Test**
 - Identify Data Voids & Uncertainties
 - Assist in Realistic Test Design
- **Enhance Survivability**

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